

# The Role of CCLs and WCCs in the GAW Programme for the Observation of Greenhouse Gases

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Umwelt  
Bundes  
Amt   
Für Mensch und Umwelt

***2nd International Workshop on Atmosphere Watch in Asia  
– Greenhouse Gases Monitoring Activities –  
Jeju, Republic of Korea, October 21 – 22, 2010***

# The Role of Central Calibration Laboratories (CCL) and World Calibration Centres (WCC) in the GAW Programme for the Observation of Greenhouse Gases

## Outline

1. CCLs and WCCs according to WMO/GAW Strategic Plans
2. Tasks
3. Data quality objectives defined by GAW
4. Calibration scales for CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O and hierarchy of standards (traceability)
5. Audits (definitions, procedures, summary of findings)
6. Other activities of the WCCs

In spite of the name, WCCs do not prepare their own primary standards, but are linked to the respective WMO/GAW scale maintained by the Central Calibration Laboratory.

# CCLs and WCCs according to Strategic Plans

Strategic Implementation Plans →

GAW Reports No. 142, 156, 172

<http://www.wmo.int/pages/prog/arep/gaw/gaw-reports.html>

**No. 142 (2001). Strategy for the Implementation of the Global Atmosphere Watch Programme (2001-2007), A Contribution to the Implementation of the Long-Term Plan (WMO TD No.1077)**

*Comment: Contains a list of Quality Assurance/Science Activity Centres (QA/SACs) and WCCs. However, GAW CCLs not yet mentioned.*

**No. 156 (2004). Addendum for the period 2005-2007 to the Strategy for the implementation of the Global Atmosphere Watch Programme (2001-2007), GAW Report No. 142, (WMO TD No. 1209)**

*Comment: CCLs for CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O listed under Central Facilities.*

**No. 172 (2008). WMO/GAW Strategic Plan: 2008-2015 - A Contribution to the Implementation of the WMO Strategic Plan: 2008-2011 (WMO TD No. 1384), 108 pgs, August 2008**

*Comment: Details in Table on next page*

# WMO/GAW Report No. 172:

**Table 1: Overview of the GAW World Central Facilities (as of May 2007). The World Central Facilities have assumed global responsibilities, unless indicated (Am: Americas; E/A: Europe and Africa; A/O: Asia and the South-West Pacific).**

Variable	QA/SAC	Central Calibration Laboratory (CCL) Host of Primary Standard	World Calibration Centre (WCC)	Regional Calibration Centre (RCC)	World Data Centre (WDC)
CO <sub>2</sub>	JMA (A/O)	ESRL	ESRL		JMA
CH <sub>4</sub>	Empa (Am, E/A) JMA (A/O)	ESRL	Empa (Am, E/A) JMA (A/O)		JMA
N <sub>2</sub> O	UBA	ESRL	IMK-IFU		JMA

**In addition (as of 2010):**

**In the following focus on:**

SF <sub>6</sub>	ESRL
CO <sub>2</sub>	Empa

CO<sub>2</sub>  
CH<sub>4</sub>  
N<sub>2</sub>O

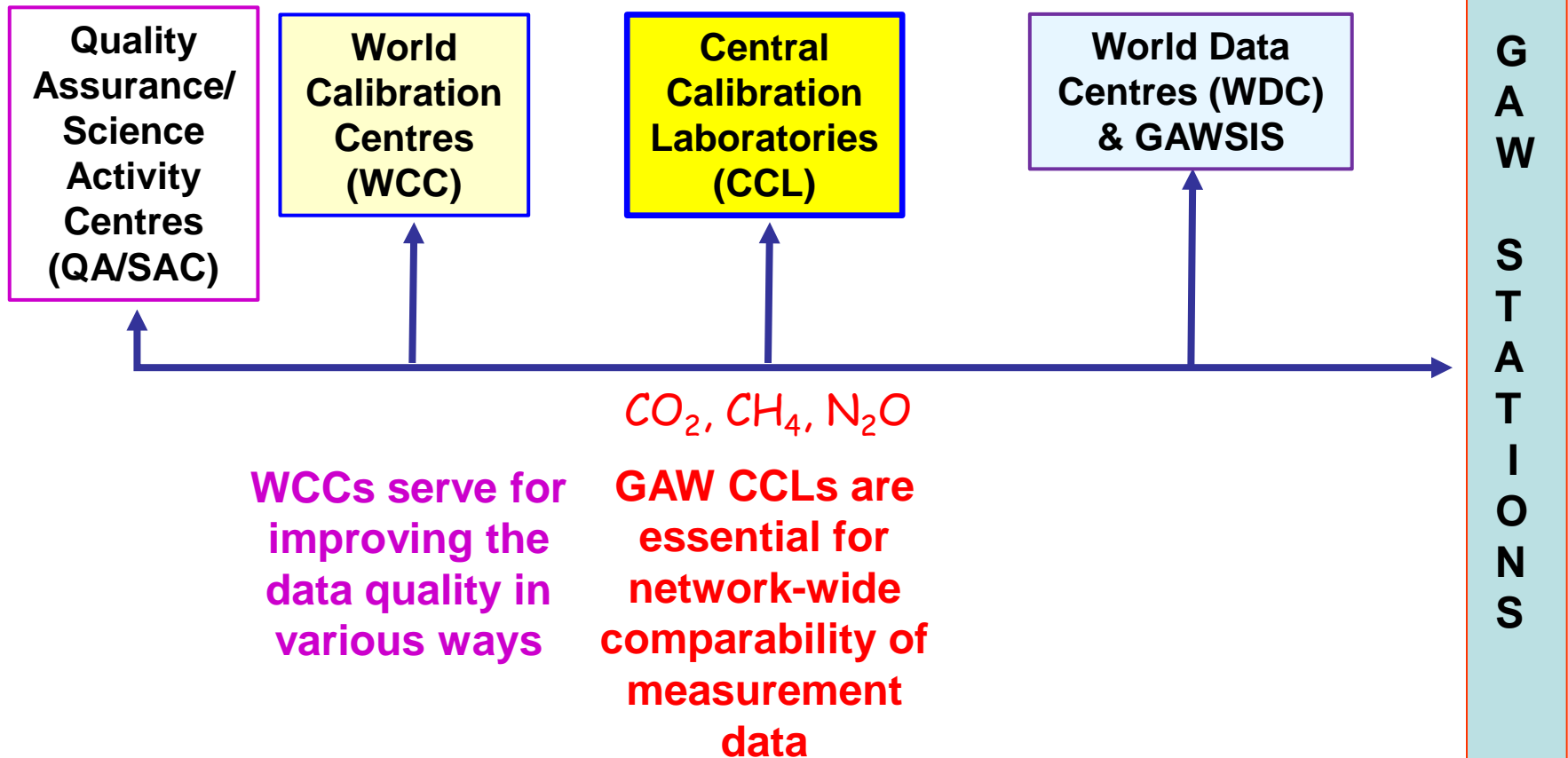
Empa	WCC-Empa, Switzerland
ESRL	NOAA ESRL, USA
IMK-IFU	KIT, IMK-IFU, Germany
JMA	Japan Meteorological Agency
UBA	German Environment Agency

CH<sub>4</sub>, CO<sub>2</sub>  
CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O  
N<sub>2</sub>O  
CO<sub>2</sub>, CH<sub>4</sub>  
N<sub>2</sub>O

# Global Atmosphere Watch (GAW)



## GAW Central Facilities:



# Tasks of CCLs

Terms of Reference, GAW Report No. 172, p.15

- Host in the long term (many decades) the GAW primary standard and scale for a particular variable.
- Serve the needs of the other quality assurance facilities and activities of GAW.
- Prepare or commission laboratory standards required by the GAW network members for calibration purposes.
- Supply well-calibrated air to GAW analytical laboratories as needed for conducting inter-comparisons (in collaboration with the World or Regional Calibration Centres).

## Additional information:

Historically, individual institutes maintained their scale for GHG measurements, without systematically fulfilling all above tasks.

In recent years comparisons with CIPM-related institutions (International Committee for Weights and Measures)

### April 2010: CIPM Mutual Recognition Arrangement

The World Meteorological Organization (WMO) has become the second intergovernmental organization to join the [CIPM MRA](#).

#### → Climate change - WMO signed the CIPM MRA!

The "[WMO-BIPM Workshop on Measurement Challenges for Global Observation Systems for Climate Change Monitoring: Traceability, Stability and Uncertainty](#)" was held from 30 March to 1 April 2010, at the WMO headquarters in Geneva, Switzerland, under the chairmanship of Prof. Andrew Wallard (BIPM) and Dr Wenjian Zhang (WMO).

At the occasion of the Workshop, **the World Meteorological Organization (WMO) joined the CIPM MRA**. The signing ceremony took place on 1 April 2010, when Michel Jarraud, Secretary General of the WMO, signed the Arrangement on behalf of the WMO.

**WMO-BIPM Workshop on Measurement Challenges for Global Observation Systems for Climate Change Monitoring: Traceability, Stability and Uncertainty**  
30 March-1 April 2010



Source of information:

<http://www.bipm.org/en/cipm-mra/>

# Details : GAW CCL for CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O

U.S. Department of Commerce | National Oceanic & Atmospheric Administration | NOAA Research



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<http://www.esrl.noaa.gov/gmd/ccl/>

## WMO GAW Central Calibration Laboratories

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NOAA ESRL GMD is the World Meteorological Organization (WMO), Global Atmosphere Watch (GAW) Central Calibration Laboratory (**CCL**) for CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, SF<sub>6</sub>, and CO. In support of GAW, GMD offers calibration services for these gases for a fee. ESRL/GMD also can also calibrate compressed gas standards to NOAA/GMD internal scales for other gases, such as CFCs, HCFCs, and the stable isotopes of CO<sub>2</sub>.

### About the ESRL CCL

A WMO Central Calibration Laboratory is responsible for maintaining and distributing the WMO Mole Fraction scale for a specified gas in air.



# Tasks of WCCs

Terms of Reference, GAW Report No. 172, p.16

- Development of quality control procedures (in co-operation with the respective QA/SAC and SAG)
- Maintaining laboratory and transfer standards that are traceable to the standard scale
- Conducting performance and system audits at stations
- Conducting round-robin experiments (intercomparisons) and participation in international intercomparisons
- Providing training and long-term technical help for station scientists and technicians
- To assist members operating GAW stations to link their observations to the GAW primary standard

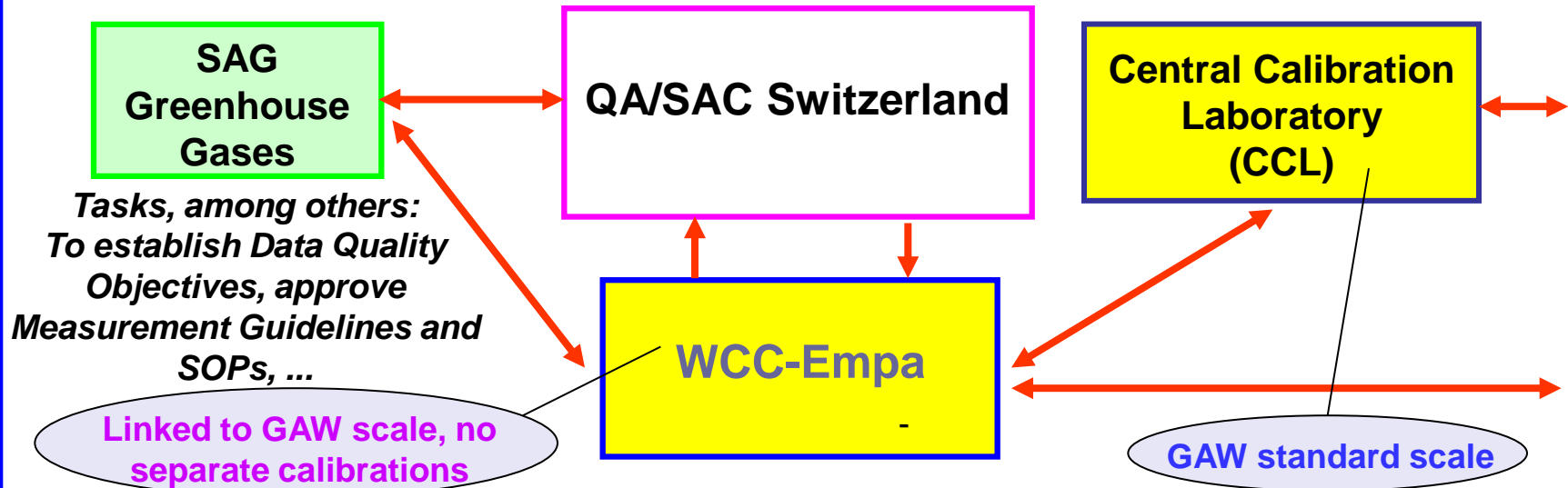


# WCC-Empa within GAW

Responsibility, among others, for CH<sub>4</sub> and – recently added – CO<sub>2</sub>

## Global Atmosphere Watch (GAW)

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Empa - a Research Institute of the **ETH Domain**

Materials Science & Technology

You are here: [empa.ch](#) > [Departments](#) > [Mobility](#) > [Air Pollutio ...](#) > Global

## World Calibration Centre (WCC-Empa) for Surface Ozone, Carbon Monoxide and Methane

WCC-Empa was established in 1996, assuming worldwide responsibility for surface ozone, carbon monoxide and methane inter-comparisons at global GAW stations.

The **goals** of the WCC-Empa are

- To ensure that measurements are fully traceable to the designated GAW reference
- To assist stations with regards to instrument and/or measurement problems
- To improve technical know-how at stations through on-site training

through

- Regular system and performance audits at global GAW stations including inter-comparison measurements with traveling standards.
- Maintaining laboratory and traveling standards for surface ozone, carbon monoxide and methane.

### more about...

[Global Atmosphere Watch](#): Introduction

World Calibration Centre (WCC) for Surface Ozone, Carbon Monoxide and Methane

[QA/SAC Switzerland](#) (Quality Assurance/Scientific Activity Centre)

[GAW SIS](#) (GAW Station Information System)

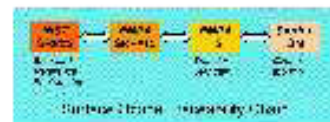
### downloads

[Questionnaire: Audit Gases](#)

[SOP: Audit Gases](#)

**Mission statement for GAW activities at Empa**

Mission statement for GAW activities at Empa

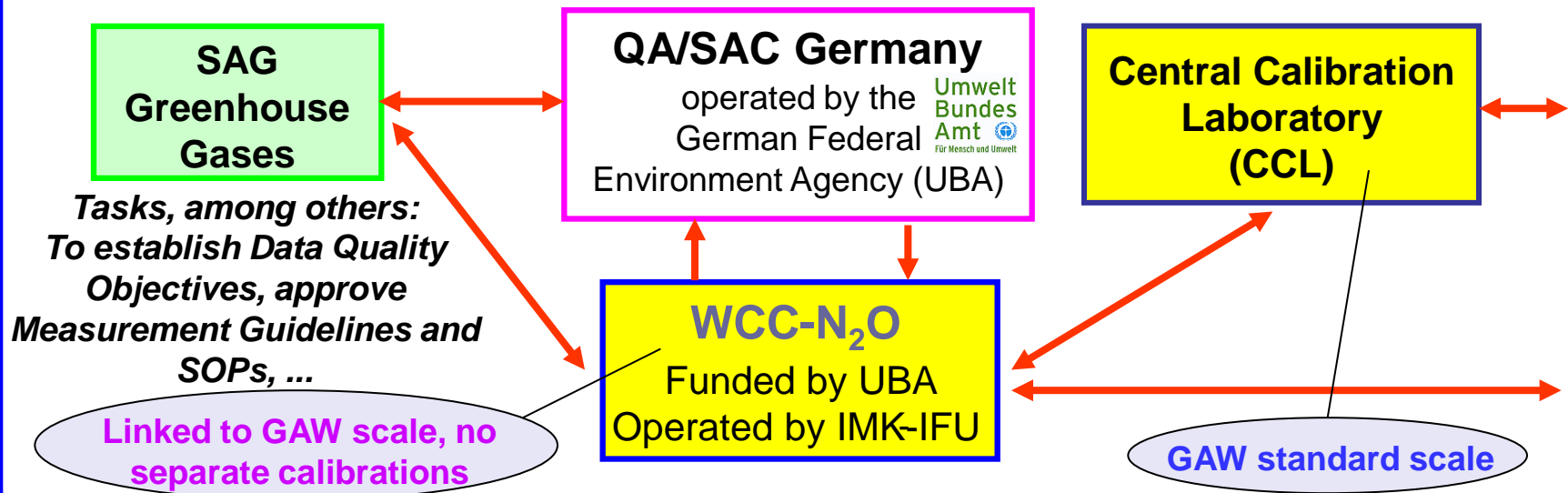


# WCC-N<sub>2</sub>O within GAW



## Global Atmosphere Watch (GAW)

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World Calibration Centre for Nitrous Oxide (WCC-N<sub>2</sub>O)

Global Atmosphere Watch (GAW)  
Programme of the World Meteorological Organization



[Home](#)

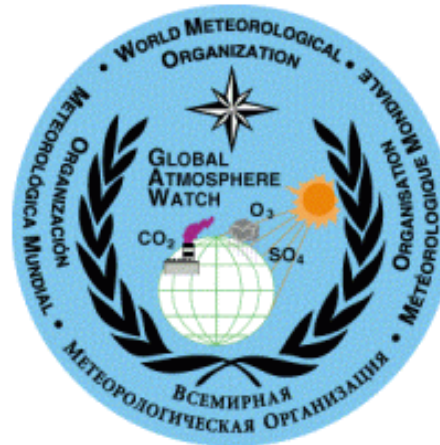
[Role of the WCC-N<sub>2</sub>O](#)

[Laboratory](#)

[Activities](#)

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[Links](#)



The WCC-N<sub>2</sub>O is hosted by the [Karlsruhe Institute of Technology \(KIT\)](#), Institute for Meteorology and Climate Research ([IMK-IFU](#)) Garmisch-Partenkirchen, Germany.

# Data Quality Objectives (DQO)

**Recommended compatibility of measurements within GAW**  
(latest version, according to draft of Expert Group Recommendations, Jena, Germany, 2009, GAW Report in preparation)

Component	Compatibility goal	Range in the unpolluted troposphere
$\text{CO}_2$	$\pm 0.1$ ppm ( $\pm 0.05$ ppm in the southern hemisphere)	360 ... 420 ppm
$\text{CH}_4$	$\pm 2$ ppb	1700 ... 2000 ppb
$\text{N}_2\text{O}$	$\pm 0.1$ ppb	320 ... 335 ppb

For a more detailed description of DQOs for  $\text{CH}_4$  and  $\text{N}_2\text{O}$  along with guidance for the measurements see:

GAW Report No. 185:  
Guidelines for the Measurement of Methane and Nitrous Oxide and their Quality Assurance

$\text{N}_2\text{O}$  in particular:  
For basic calibrations and intercomparisons, mole fractions between 290 and 350 ppb, five levels.  
→ Response curve of detector (ECD)

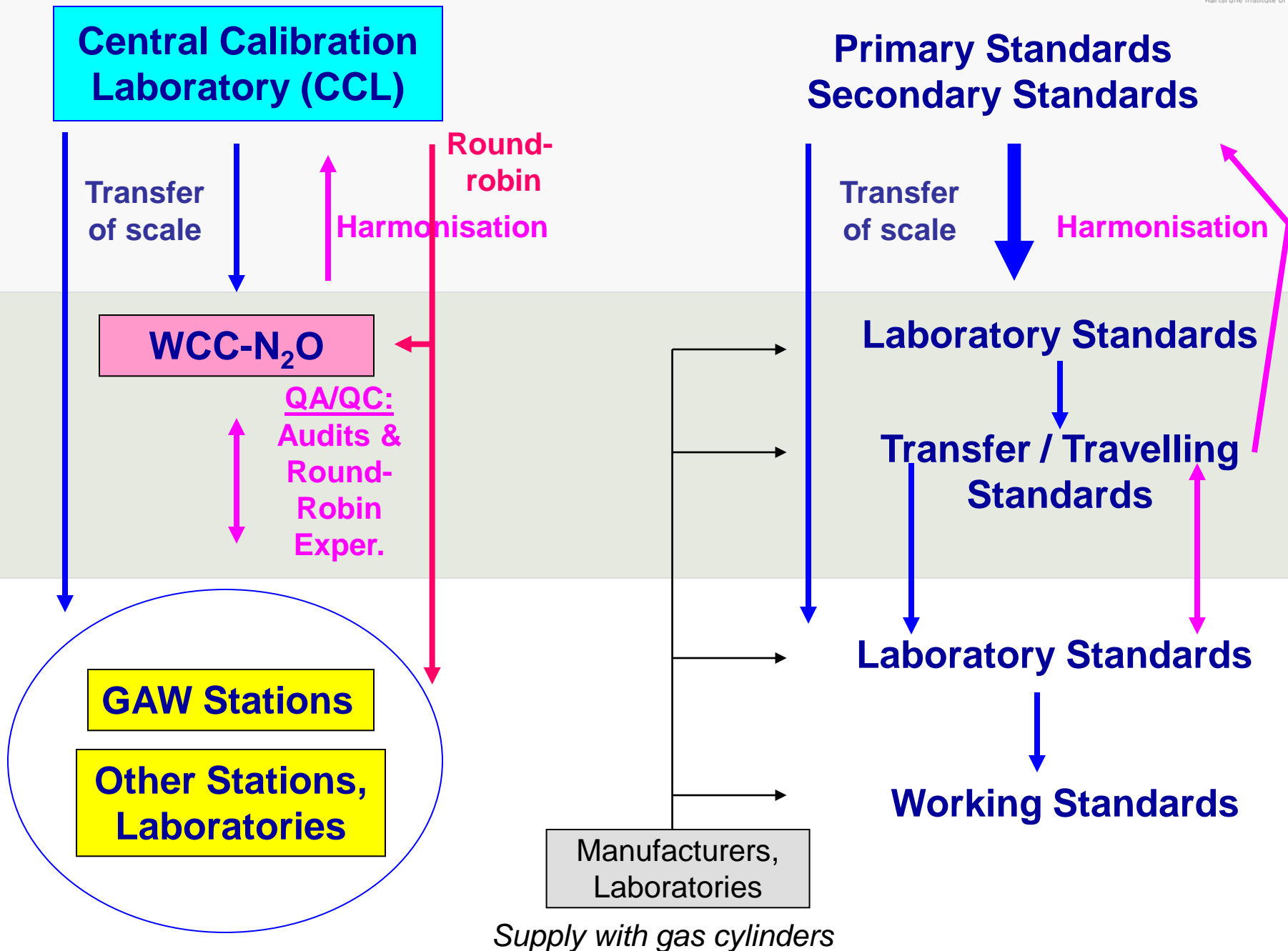
GAW Report No. 185

Guidelines for the Measurement of Methane and Nitrous Oxide and their Quality Assurance



World  
Meteorological  
Organization  
Météorologie - Climat - Eau  
WMO/TCO - No. 1478







# Results of a CCL–WCC intercomparison experiment (10-L cylinders)

5 WCC-N<sub>2</sub>O travelling standards analyzed by the CCL (Brad Hall) in 2007

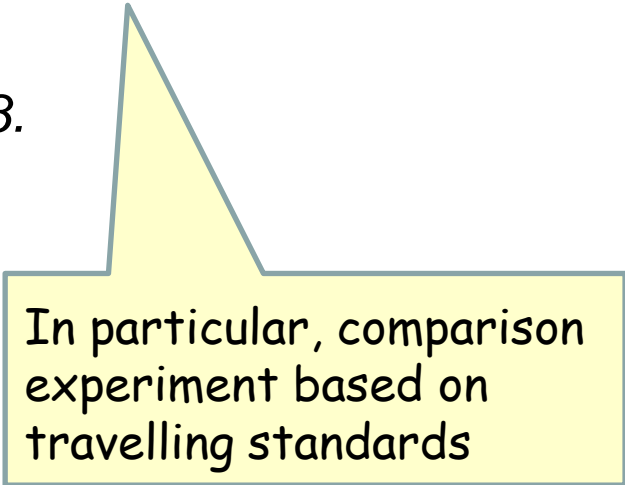
Cylinder		Additional gases in mixture		N <sub>2</sub> O [ppb] as assigned by WCC-N <sub>2</sub> O	CCL results (intercom- parison 2007) [ppb]	Diff.: WCC – CCL [ppb]
Number	Short name	CO <sub>2</sub>	SF <sub>6</sub>	Converted to NOAA-2006 scale	NOAA-2006 scale	
6061	DS 11	+	+	296.26	295.89	0.37
4616D	DS 14	+	+	305.95	305.89	0.06
4586D	DS 15	+	+	318.97	318.90	0.07
4563D	DS 13	+	+	332.65	332.77	-0.12
4594D	DS 10	+		347.47	347.35	0.12

The outlier could be explained 

**System audit:** generally defined as a check of the overall conformity of a station with the principles of the GAW QA system. It involves an assessment of the station siting, infrastructure, organization, operation, etc.

**Performance audit:** voluntary check for conformity of a measurement where the audit criteria are the Data Quality Objectives (DQOs) for the specific parameter. The audit involves ensuring the traceability of measurements to the Standard Scale.

*Adopted from GAW Report No. 172, p. 28.*



In particular, comparison experiment based on travelling standards

# Audits: Procedures (2 GAW documents)

## Standard Operating Procedure (SOP) for System and Performance Audits of Atmospheric Trace Gas Measurements at WMO/GAW Sites (approved by the SAG GG)

Instructions for auditors, covering:

Preparation of audit at home

Audit procedures on site

Completion of audit

Summary rating for audited parameter

## Audit Questionnaire for System and Performance Audits of Atmospheric Trace Gas Measurements at WMO/GAW Sites (approved by the SAG GG)

Serves for collecting all relevant information at the site.

Audit documents were developed jointly by WCC-Empa and WCC-N<sub>2</sub>O.

Collaboration between WCC-Empa and WCC-N<sub>2</sub>O for intercomparisons

## **Audit Report**

Summarizes the findings

Provides recommendations (ranked by priority)

*Format not prescribed by GAW*

*Audit reports may be added to the station reference list in GAWSIS →*

## **Post-audit Contacts / Control of Success**

Not yet standardized

Individual requests of information



by QA/SAC Switzerland

# GAW SIS

STATION INFORMATION SYSTEM

- Find Information
- Edit/Add Information
- Provide Feed-back



<http://gaw.empa.ch/gawsis/reports.asp>

- Home
- Advanced Search
- Edit/Add Information
- GAW IDs
- Feed-back
- FAQ
- About

## Station Characteristics

2010-04-16/248

**GAW ID** IZO

**station status** established 1984 / full operation

**time zone** UTC+0

**climate zone** Csb (Warm temperate climate with dry and warm summer)

**other affiliations** [AERONET\(Izana\)](#), [EMEP\(ES0018G\)](#), [NOAA-ESRL/CCG](#), [GALION](#), [NDACC](#), [TCCON](#)

**Izaña (Tenerife) (Spain)**  
**Global station in WMO RA I - Africa**  
[28.30900°N 16.49940°W](#) (2373 m a.s.l.)  
<http://www.aemet.izana.org>

**description** The Izaña station is located on the Island of Tenerife, Spain, roughly 300 km west of the African coast. The meteorological observatory is situated on a mountain platform, 15 km north-east of the volcano Teide (3718 m a.s.l.). The local wind field at the site is dominated by north-westerly winds. A predominant meteorological attribute of the Canary Islands region is the presence of the trade wind inversion that persists through most of the year and is well below the altitude of the station. The ground in the vicinity around Izaña is loosely covered with light volcanic soil. The vegetation in the surrounding area is sparse, consisting mainly of broom. About 100 m south of the station a road leads to the meteorological observatory, and also serves the astrophysical institute of the Canaries and a nearby military camp. Because the road is closed to public traffic, only approximately 5 to 10 cars a day pass the vicinity. The complementary background urban pollution research Observatory at Santa Cruz de Tenerife (SCO, 28° 28'N; 16° 15' W) is located on the roof of the IARC's headquarters at 52 m a.s.l. in the city of Santa Cruz de Tenerife, by the city harbour. This station is also part of GURME program.



## Measurement Program

type	parameter	method	contributor	start	end	details
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## References

Gomez-Pelaez, A.J., Ramos, R. (2010), Improvements in the Carbon Dioxide and Methane Continuous Measurement Programs at Izaña Global GAW Station (Spain) during 2007-2009, , *GAW Rep. to be publi*, [http://www.aemet.izana.org/publications/IzanaCO2CH4\\_15WMOCO2meeting\\_2009.pdf](http://www.aemet.izana.org/publications/IzanaCO2CH4_15WMOCO2meeting_2009.pdf)

Gomez-Pelaez, A.J., Ramos, R. (2009), Installation of a new gas chromatograph at Izaña GAW station (Spain) to measure CH4, N2O, and SF6, , *GAW Report No. 186*, 55-59, [http://www.aemet.izana.org/publications/IzanaGCCH4N2OSF6\\_ReportGAW186\\_14thGAWCO2Meeting\\_2007.pdf](http://www.aemet.izana.org/publications/IzanaGCCH4N2OSF6_ReportGAW186_14thGAWCO2Meeting_2007.pdf)

Scheel, H.E. (2009), System and Performance Audit for Nitrous Oxide at the Global GAW Station Izaña, Tenerife, Spain, November 2008, WCC-N2O Report 2008/11, [http://www.aemet.izana.org/publications/Rep\\_WCCN2O\\_2008\\_IZOaudit.pdf](http://www.aemet.izana.org/publications/Rep_WCCN2O_2008_IZOaudit.pdf)

Zellweger, Christoph, et al. (2004), System and Performance Audit of Surface Ozone Carbon Monoxide and Methane at the Global GAW Station Izana, Spain, December 2004, WCC-Empa Report 04/4, [gaw.empa.ch/audits/IZO\\_2004.pdf](http://gaw.empa.ch/audits/IZO_2004.pdf)



# Audits (N<sub>2</sub>O): Summary of findings

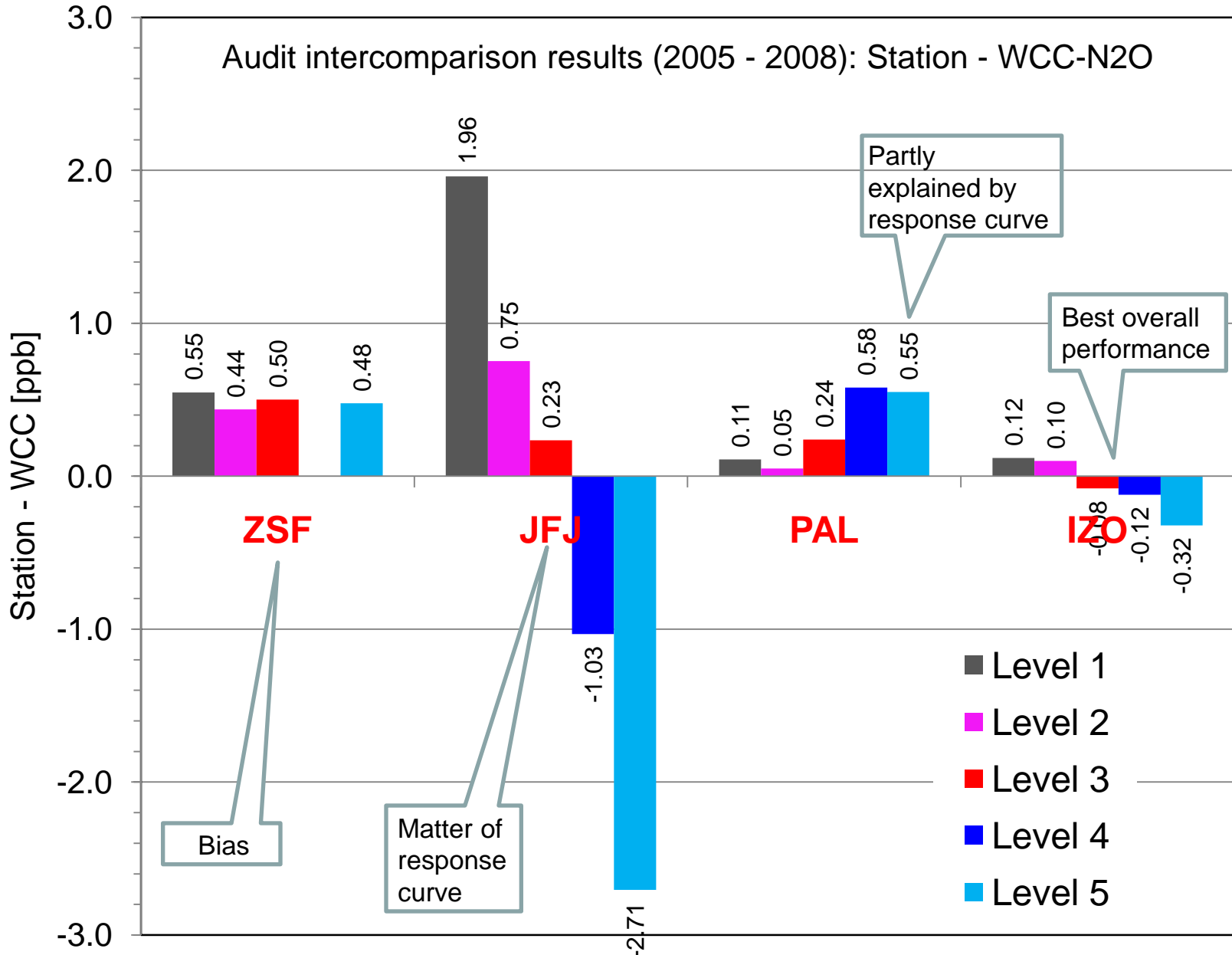
- At 2 stations only a small concentration range was covered by the standard(s) available at the site.  
The need of using a relatively wide range (290 - 350 ppb) for characterising the detector response was discussed.
- Differences between station calibration scale and WCC ⇒ Further intercomparisons necessary.
- CO<sub>2</sub> and SF<sub>6</sub> interference: Rather complex due to wide variety of GC configurations.
- Laboratory safety: High-pressure cylinders not fixed ( 2 x)

Examples of results:

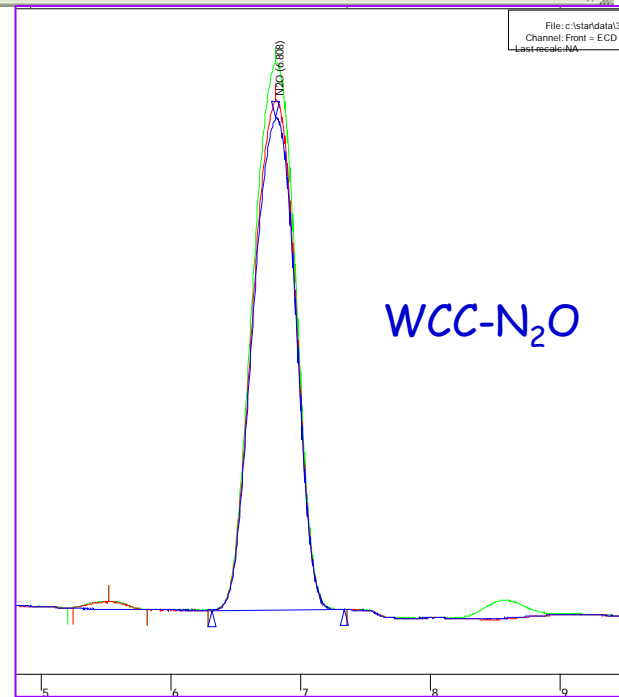
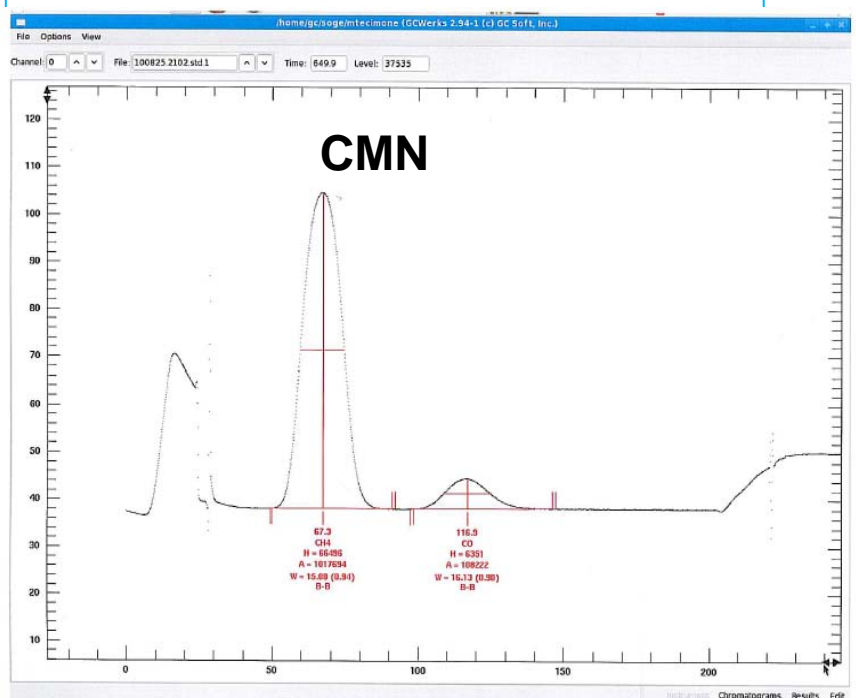
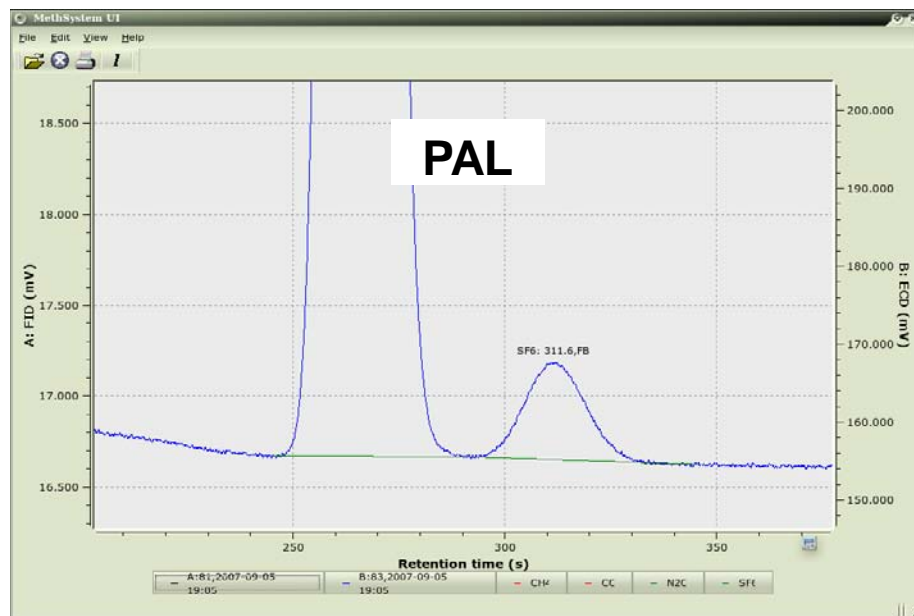
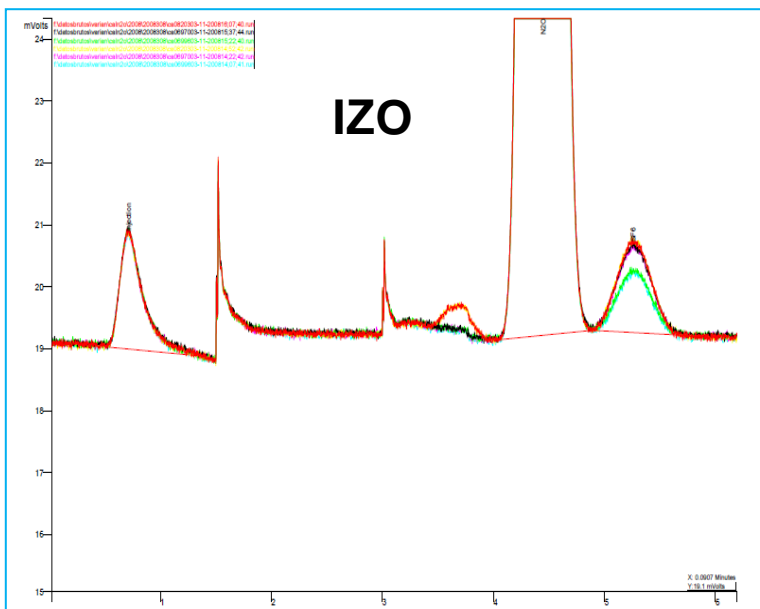
→ next pages

**IN SUMMARY:** The more recent N<sub>2</sub>O audits show better results than the earlier ones. An overall progress towards the goals of GAW is evident.

# Audit intercomparison results (2005 - 2008): Station - WCC-N2O

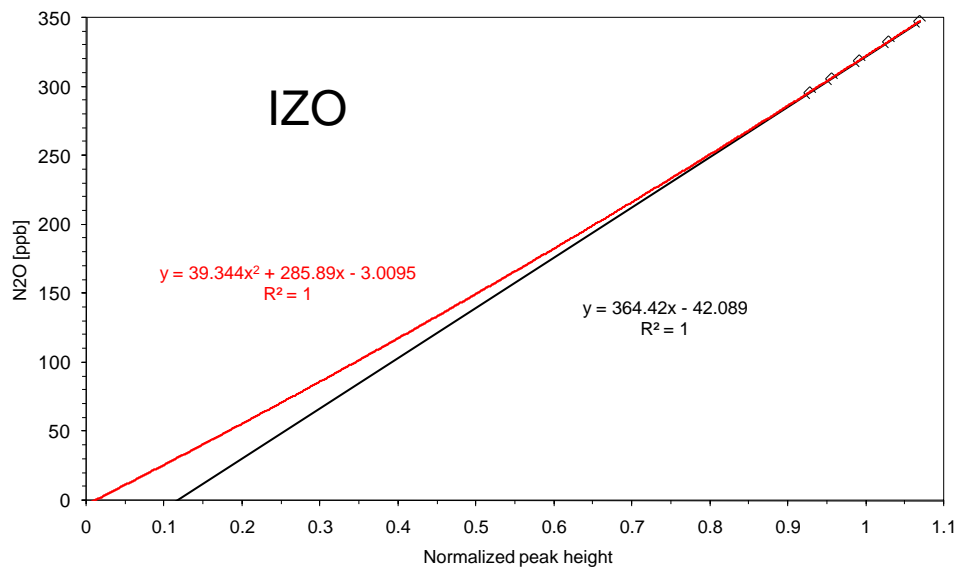
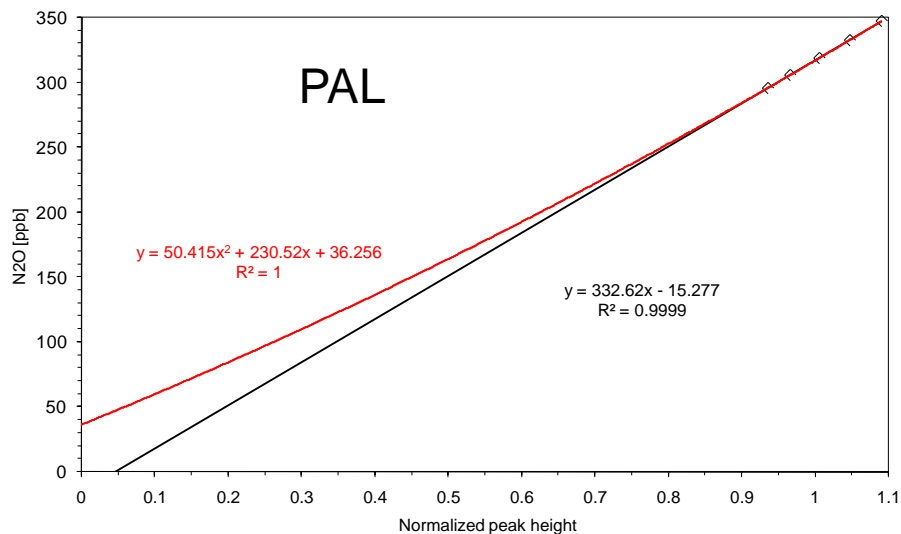
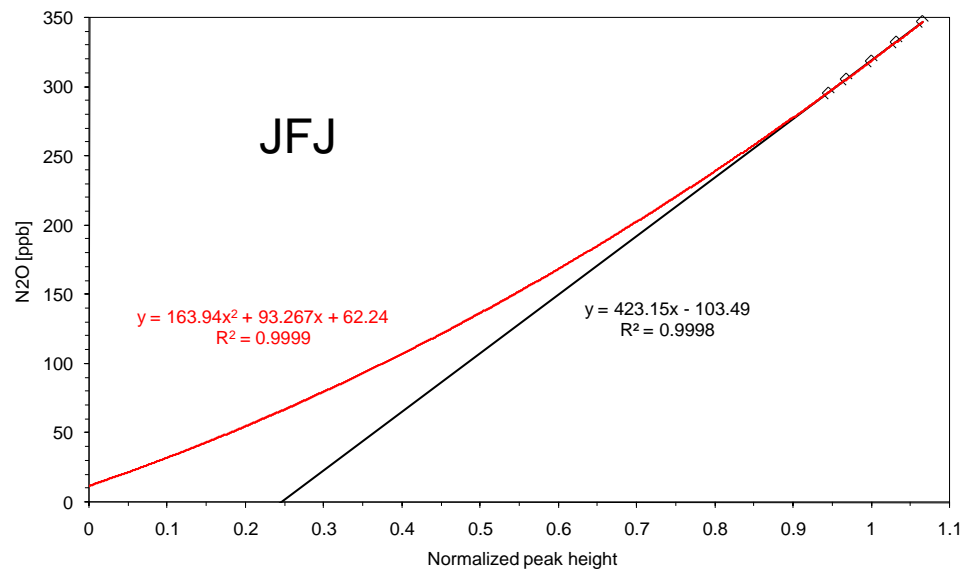
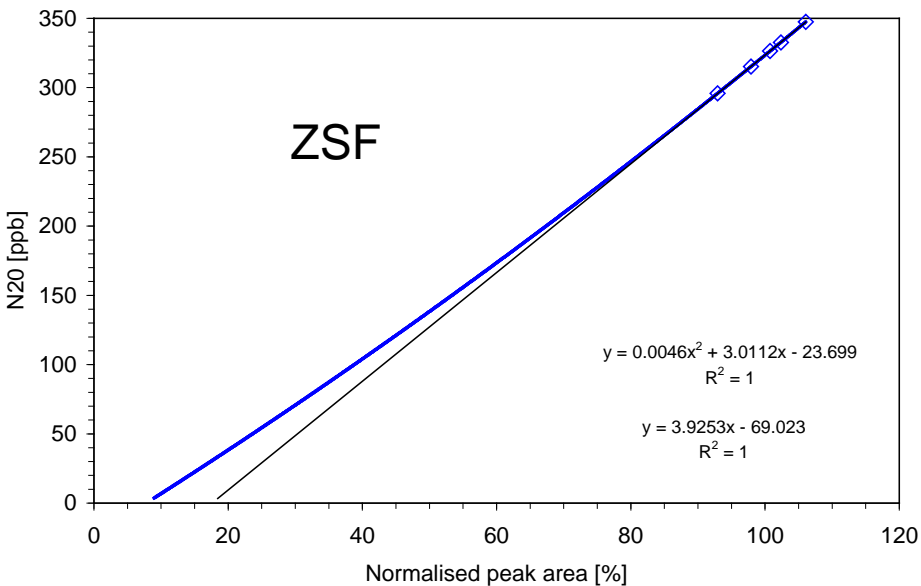


# Shape of chromatograms: Focus on separation of SF<sub>6</sub> from N<sub>2</sub>O





# Comparison of ECD response curves (extrapolated)



Range of standards: 296 - 347 ppb

## Other activities of the WCCs

### Contributions to GAW documents

Measurement Guidelines

Glossary of Terminology



Technical training and support



The GAW QA system recommends the adoption and use of internationally accepted methods and vocabulary to describe uncertainty in measurements (GAW Report No. 172).

To promote the use of common terminology, a web-based glossary has been developed.

## **WMO/GAW Glossary of QA/QC-Related Terminology**

Version 1.0 2010-09-14

Version 0.4 2007-04-26 (for comparison only - no longer recommended)

Editors: J. Klausen, H.-E. Scheel and M. Steinbacher

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<http://gaw.empa.ch/glossary/glossary.html>

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Glossary

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- SECTION 4 - Properties of Measuring Devices
- SECTION 5 - Measurement Standards
- ADDITIONAL TERMS FOR GAW

Explanations & Recommendations

References



# Global Atmosphere Watch Training & Education Centre



- scientific guidance and instructions for GAW station personnel from worldwide global and regional stations

GAWTEC Home
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## Welcome to the GAWTEC Homepage

**GAWTEC**, the **Global Atmosphere Watch Training & Education Centre**, provides scientific guidance and instructions to GAW station personnel from worldwide global and regional stations.

GAWTEC 19:

The next course on greenhouse gases will be held  
October 17th - 30th, 2010

<http://www.gawtec.de/index.html>

**WCC-Empa and WCC-N<sub>2</sub>O contribute to  
GAWTEC courses by way of lectures & advice to  
trainees**

Location: Environmental Research Station  
Schneefernerhaus (Zugspitze, Germany)  
<http://www.schneefernerhaus.de>



# Thank you!

A special word of thanks to KMA and KRISS  
for the invitation to the workshop